CLEAN SPECIFICATION

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Method for Controlling the Engine of a Motor Vehicle Having

a Manual Transmission

The invention relates to a method for controlling the engine of a motor vehicle having a manual transmission.

Background of the Invention

In motor vehicles with manual transmissions there is a mechanical clutch which can normally be actuated by way of a foot pedal by the driver of a motor vehicle during a shifting process which takes place by manual actuation of the manual transmission to interrupt the flow of power between the engine and transmission of the vehicle. At high engine speed in idle and in a start-up process which takes place at high engine speed (for example, in a racing start with a slipping clutch) very high frictional work is transmitted to the clutch due to the large difference in speed between the engine and transmission. This leads to very strong thermal loading of the clutch; this results in premature clutch wear, especially for high-torque and high-pickup, high-revolution engines with four-wheel drive.

The object of the invention is to devise a method for engine control of a motor vehicle with a manual transmission, in which the adverse effects on the clutch, especially in the start-up process and in idling of the motor vehicle, are avoided.

Summary of the Invention In a motor vehicle with manual transmission in which there are no means for direct determination of the engaged gear, a reduction of the setpoint engine torque required by the driver by actuating the accelerator is allowed in particular for limiting the engine torque as long

as at least one definable (applicable) approval criterion for the driving state of the motor vehicle is satisfied. In this connection at least one approval criterion dependent on the driving speed of the motor vehicle is used, especially a definable, applicable speed threshold not being reached by the driving speed of the motor vehicle; in this connection, preferably a value in the range from 30 km/h to 40 km/h, or a value below 40 km/h, for example a value of approximately 35 km/h, is defined as the speed threshold for the driving speed of the motor vehicle. Accordingly, at a driving speed of zero of the motor vehicle (when the vehicle is idling) or at a driving speed of the vehicle which is less than the speed threshold (in the process of the vehicle's starting up), instead of the setpoint engine torque required by the driver by actuating the accelerator, especially to limit the engine speed a default engine torque is determined which is reduced relative to the setpoint torque under certain assumptions. Optionally another approval criterion (especially in the process of the vehicle's starting up) is the applicable delay time, i.e., a possible reduction of the setpoint engine torque required by the driver by actuating the accelerator and thus the stipulation of a default engine torque which may deviate therefrom is approved only after a certain time interval has elapsed after recognition of the process of the vehicle's starting up. This delay time (for example 500 ms) can be used especially in motor vehicles with a slow build-up of engine power or engine torque as the approval criterion, for example in motor vehicles with turbochargers in which a slow build-up of the charging pressure takes place.

The default engine torque is determined in this process depending on at least one engine characteristic, preferably the engine speed on the one hand and the quotient of the engine speed and the driving speed of the vehicle on the other are used as engine characteristics. To generate the default engine torque, a torque factor to which values in the range from 0 to I are assigned is applied to the setpoint engine torque; the default engine torque thus deviates from the setpoint engine torque and is reduced relative to the setpoint engine torque if the torque factor does not reach 1; this is preferably the case when the engine speed of the vehicle exceeds a definable speed threshold (for example, a value of 4600 rpm is defined as the speed threshold) and when the quotient of the engine speed and the driving speed of the vehicle is within a definable value range (for example, between 100 min^{-1}/km/h and 500 min^{-1}/km/h). The torque factor can be determined from the characteristic map in which the engine characteristics used, preferably the engine speed and the quotient of the engine speed and the driving

speed of the vehicle, are displayed. A default engine torque which has been reduced compared to the setpoint engine torque (for a torque factor which drops below 1) is ordinarily implemented by an action which influences the engine torque, especially by an action on the throttle valve and/or ignition and/or the fuel injection of the vehicle.

Preferably, with this process, without the requirement of explicit recognition of the engaged gear, a significant reduction of the stress on the clutch and thus avoidance of overloads on the clutch can be ensured by limiting the engine torque and accordingly the engine speed both when the vehicle is idling and also when the vehicle is starting up. In racy start-up maneuvers, especially in the case of starting up with high speed and load, adverse effects on agility, acceleration behavior or driving comfort of the vehicle are avoided based on the uniform influence on the default engine torque as a result of the engine characteristics engine speed and driving speed which are preferably used and as a result of avoiding sudden changes of torque limitation when the gears are recognized and changed. When the vehicle is idling the limitation of engine torque and accordingly the engine speed can be used for acoustic purposes.

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Brief Description of the Drawings

FIG 1   shows a block diagram of the torque control,

FIG. 2   shows the variation of the position of the accelerator and throttle valve as a function of time in the start-up process,

FIG. 3   shows the variation of various engine characteristics in the start-up process as a function of time.

Detailed Description of the Preferred Embodiment of the Invention

FIG. 1 shows a block diagram of an engine control which influences the start-up process of a vehicle with a manual transmission.

Influencing the setpoint engine torque M_s required by the driver of the vehicle by actuating

the accelerator (see FIG. 2) and thus the stipulation of a default engine torque (M_v ($M_v \leq M_s$)) which may have been reduced in comparison here is allowed only when at least one approval criterion is met. The approval criterion to be met is for example the start-up or initial rolling of the vehicle (driving speed v of the vehicle > 0; this is checked by means of a comparator 4), the progression of the delay time τ (the delay time τ of for example 500 ms is set by the delay element 5) and failure to reach a speed threshold v_s (driving speed v of the vehicle < speed threshold v_s of for example 35 km/h; this is checked by means of the comparator 3). When all approval criteria are met, at the output of the logic element 7 a corresponding logic signal is delivered to the control line 9 and actuates the switching element 2 which switches from the input line 9 (stipulation of a default torque M_v at the output 8 of the switching element 2 is blocked) to the input line 10 (stipulation of a default torque M_v at the output 8 of the switching element 2 is cleared). By multiplication of the setpoint engine torque M_s by the torque factor MF (MF $\leq$ 1) a default torque M_v is generated which is at most as large as the setpoint engine torque M_s under certain circumstances, but smaller than the setpoint engine torque M_s (no reduction of the setpoint engine torque M_s at MF = 1; reduction of the setpoint engine torque M_s at MF < 1). To determine the torque factor MF with the input line 10 of the switching element 2 isolated, the two engine characteristics speed n on the one hand and the quotient Q of engine speed n and the driving speed v of the vehicle on the other are used and are sent as input values to the characteristic map 1, at the output of which the torque factor MF (MF $\leq$ 1) is output to the input line 10. For example, the torque factor MF is only then different from 1 (MF < 1) and in this way by way of the output 8 of the switching element 2 causes an action on the setpoint engine torque M_s to limit the engine speed, when the engine speed n exceeds the speed threshold n_s (for example a value of 4600 min^{-1} is stipulated as the speed threshold) and the quotient Q of the engine speed n and the driving speed v of the vehicle is within a certain value range (for example, this range of values from 150 min^{-1}/km/h to 500 min^{-1}/km/h is stipulated; this corresponds approximately to the range of first gear of a conventional manual transmission). The action to reduce the setpoint engine torque M_s to the default torque M_v for a torque factor MF less than 1 (MF < 1) can take place for example by way of the throttle valve or the injection instant or the ignition instant.

FIGS. 2 and 3 shows the variation of certain engine characteristics of a motor vehicle with a

manual transmission in a racing start (start-up of the vehicle at full throttle and with clutch depressed) as a function of time. FIG. 2 shows the variation of the position of the accelerator dictated by the driver as a function of time (curve (a) as a measure for the setpoint engine torque M_s) and the position of the throttle valve (curve (b) as a measure of the default torque M_v), in FIG. 3 the variation of the driving speed v (curve (c) as a function of time), the engine speed n (curve (d)), of the quotient Q of the engine speed n and the driving speed v (curve (e)), and of the torque factor (curve (f)).

At time t_1 before the vehicle starts off, for a racing start the accelerator is completely depressed (curve (a)) and accordingly the throttle valve is completely opened (curve (b)), at the same time the clutch pedal is depressed. The engine speed n (curve (d)) rises to a critical value of for example 5800 min^{-1} which is above the speed threshold n_s of for example 4600 min^{-1}.

At time t_2 when the vehicle starts up (starting to roll) the clutch is suddenly or gradually released, the accelerator (curve (a)) remains completely depressed and the throttle valve (curve (b)) is completely (100%) opened (full throttle), by which the driving speed v (curve (c)) assumes a non-zero value (v > 0). The engine speed n (curve (d)) remains at a value above the speed threshold n_s (for example, 4600 min^{-1}). As a result of the high rpm difference between the engine and transmission of the vehicle, this can lead to thermal overloading of the clutch and thus wear (failure) of the clutch.

At time t_3, immediately after the vehicle starts up however limitation of the engine torque M from the setpoint engine torque M_s to the default torque M_v is effected however by way of the torque factor MF, since on the one hand the approval criteria for the default torque M_v are satisfied (driving speed v > 0 and driving speed v is less than the speed threshold v_s of for example 35 km/h), a delay time τ after time t_2 (start-up of the vehicle) is for example not stipulated (τ = 0), and on the other hand, based on the values of the engine characteristics, engine speed n and quotient Q of the engine speed n and the driving speed v, as the input quantities of the characteristic map 1 (in particular, the engine speed n exceeds the torque threshold n_s of 4600 min^{-1}, while the quotient Q is in a stipulated value range which is characteristic of first gear), a torque factor different from 1 is output by the characteristic map 1 (MF ≤ 1, for example the minimum value of MF is approximately 0.3). In this

way the completely opened throttle valve (throttle valve opening 100%) is again partially closed (opening of the throttle valve < 100%, for example approximately 20% opening of the throttle valve) and therefore a default torque M_v reduced compared to the setpoint engine torque M_s is delivered as the engine torque; this also causes a reduction of the engine speed n which accordingly drops below the speed threshold ns of 4600 min [1].

At time t_4, based on the now altered values of the engine characteristics engine speed n and quotient Q of the engine speed n and driving speed v as the input quantities of the characteristic map 1 (especially by reducing the engine speed n, which thus again falls below the speed threshold n_s of 4600 min^{-1}) again the value 1 for the torque factor MF is output by the characteristic map 1 (MF =1), by which the throttle valve (curve (b)) is opened again according to the position of the accelerator (curve (a)) (opening of the throttle valve to 100%) and the default torque M_v which corresponds to the setpoint engine torque M_s is delivered as the engine torque.

At time t_6, when the speed threshold v_s of for example 35 km/h is reached for the driving speed v, the approval criterion for the stipulation of the default torque M_v is no longer satisfied, so that starting from this instant t_5 the stipulation of the default torque M_v is deactivated. In this way the switching element 2 as shown in FIG. 1 is switched to the input line 9 and the setpoint engine torque M_s required by the position of the accelerator is output on the output line 8 of the switching element 2.